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ABSTRACT

The main purpose of the research was to make a comparative study of: (1) trial-and-error learning, in which a subject performs and is provided with knowledge of results; and (2) observational learning, in which a subject either observes the performance of another subject or is otherwise provided with equivalent information as to the correctness and incorrectness of responses. In general, the earlier results showing superiority of observation learning were not substantiated. Other results indicated that male college students form new associations more rapidly under performance and less rapidly under observation, and that both sexes tend to repeat errors more often over trials under performance and less often under observation. Also, college students in other experiments learned more effectively on the second of two functions, whether it was performance or observation, indicating the role of a warm-up or learning-to-learn factor. (Author)

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Abstract

The main purpose of the research was to make a comparative study of trial-and-error learning, in which a subject performs and is provided with knowledge of results, and observational learning, in which a subject either observes the performance of another subject or is otherwise provided with equivalent information as to the correctness and incorrectness of responses. Elementary-school children were trained and tested in their normal classroom setting and college students were used as subjects both in small groups and in computer-controlled laboratory booths. In general, the earlier results showing superiority of observation learning were not substantiated; it is concluded that the discrete stimulus-response items used in the present tasks are not as likely to provide an advantage to an observer as the more sequential type of items used previously by Hillix and Marx and by Rosenbaum in research demonstrating observer superiority. Other results indicated that male college students form new associations more rapidly under performance and less rapidly under observation, and that both sexes tend to repeat errors more often over trials under performance and less often under observation. Also, female college students working together, in the laboratory booth, failed to improve as did all of the other groups. College students in other experiments learned more effectively on the second of two functions, whether it was performance or observation, indicating the role of a warm-up or learning-to-learn factor. Finally, a relative improvement in observational learning was demonstrated in elementary-school children from the fourth to the sixth grade. Some theoretical interpretations and implications for further research and classroom instruction were drawn from these results.

PURPOSE

The primary objective of the research was to analyze the role of trial-and-error behavior--here called "performance," which includes decision-making and knowledge of results--and observation as determinants of efficiency in learning. A performer is typically a decision-maker, an "active" subject who both makes and registers the behavioral decisions, making overt responses and receiving information regarding the correctness or incorrectness of the responses. The observer is a "passive" subject who typically watches the performer and does not engage in any overt activity but receives equal information regarding the response to the stimuli presented.

The experiments were initially designed to produce some preliminary answers to such questions as: Is observational learning or decision-making (performance) learning generally more efficient? Is either type of learning more efficient with certain types of materials? If there are such differences, why do they occur? Is there something that happens when the performer makes a response which is rewarded that strengthens the response in a manner that goes beyond the using by the subject of the information provided by the reward, as Thorndike held (law of effect)? If the response is incorrect, is that response also strengthened on the basis of its occurrence, even in the absence of reward (Thorndike's law of exercise)? If learning is superior by either observation or performance, is the superiority found in short-term retention or long-term? Does this learning transfer to other learning tasks?

A second initial objective was to investigate the role of such salient processes as interfering responses and rehearsal in learning under performance and observation. Under conditions where observer superiority is found, for example, can this be explained because the performer must make responses such as manipulation of materials which interfere with learning? Does the observer in some manner receive vicarious reward, or could the fact that he has more time to practice (rehearse) account for any superiority of his learning?

While the initial purposes were as stated above, we will report also on other factors which were found to be significant in the analysis of the data. For example, the factors of sex, age, and the nature of the instructional materials emerged as influential manipulated variables. Also, the measure of persistence of errors was found to be significantly related to the observation/performance variable.

BACKGROUND

Experimental evidence from as early as the mid-1930's appears to support two points of view regarding the nature of reward when responses are emitted in instrumental learning tasks. The best-known of these early researchers was Thorndike (1933, 1935). He held that the action of reward is essentially automatic and noncognitive and that some physiological (brain) event occurs (confirmatory or "OK" reaction) when a response is rewarded which strengthens that stimulus-response bond. A contrary view was expressed by researchers such as Tolman, Hall, and Bretnall (1932), who held that the strengthening observed is due to the information given by the aftereffect. Muenzinger (1934) showed that information can strengthen connections for human subjects even though no obvious reward is obtained through manipulated aftereffects.

The Thorndikian view would lead one to predict superior learning by the performer in the present context. However, the alternative cognitive view would predict no difference in learning, because of the equal information received in each case. Since the observer who makes no overt response cannot receive the same kind of response-contingent reward as the performer, he must therefore in some way be remembering and utilizing the information received. The experiments were designed to provide both observer and performer with equal information, but to provide the performer with the additional factor of reward.

Impetus for the research reported here came from the Hillix and Marx (1960) experiments which showed superior learning by the observers. These results and the procedure used are reviewed here.

College students learned sequential multiple-choice tasks, consisting of patterns of lights which could be turned on by toggle switches. Although in each of the two treatment conditions the experimenter actually tried the switches, in order to equalize physical activity, the groups were differentiated in terms of whether the subject himself made the decisions as to which switches to try or merely observed these tries made by the experimenter. All subjects called out the identification of each switch tried, the experimental subjects determining this themselves and the control subjects confirming the experimenter's performance. The two groups were thus differentiated only by the fact that experimental subjects actually made the decisions on which switches were tried while control subjects merely observed the procedure.

An unexpected but important result of each of the two experiments performed was that the control (observing) subjects reliably surpassed the experimental (decision-making) subjects on paper-and-pencil tests on the light circuits following complete trials through each of the five circuits that were to be learned. This result seemed to violate the general assumption that the more active learner is the superior learner (Hovland, 1951).

In regard to the inferiority shown by the "decision-making" learner, Hillix and Marx (1960, p. 100) concluded: "Their inferiority in learning indicates that the activity variable may be less important than is generally supposed. In fact, there is surprisingly little controlled experimental evidence for the generally beneficial effect of activity in human associative learning. The present results indicate a need for investigation of which kinds of materials are more effectively learned in a relatively passive manner through the presentation of information alone."

The results were attributed to three factors: (1) the greater strength of interference from self-made errors, which had been earlier suggested (Farber, 1940; Marx, 1941; Stone, 1950); (2) absence of any appreciable amount of rehearsal time for the experimental (active, decision-making) subject in the 5-sec. interresponse interval; and (3) the greater amount of "strain" placed on the experimental subject.

Another aspect of the basic experimental design and one that was the original primary purpose of the Hillix and Marx (1960) study, concerns the question of whether effect (reward) added to information produces a greater reinforcement or strengthening of stimulus-response connections, as Thorndike's law of effect holds. In the Hillix and Marx experiment this question was answered by means of a transfer test, in which the subject was administered new, problem-solving tasks and was given an opportunity to use either old (previously reinforced) sequences of responses or new sequences of responses. In the first, and more extensive, of the two replications the question was answered in the affirmative: experimental subjects (those given information plus effect, as participants) solved problems with solutions in the old learned-response sequences with a reliably greater frequency than control subjects (observers), as compared with problems involving solutions in the new response sequences.

In a more recent series of experiments reported by Rosenbaum and associates attempts were made to see if superior observer learning would be found on a similar task and to test certain of the Hillix and Marx assumptions regarding why observers showed superior learning. Rosenbaum and Schutz (1967) had subjects explore a multiple-choice maze. Performers utilized either a stylus or a radio tube to make each response in the presence of observers. Decisions about which response to make were made by either observers or performers, but in both cases the performers actually made the responses. This experiment was designed to test the hypothesis that decision making and complex response requirements interfere with learning, two possible reasons why observers show superiority of learning. In a discussion of their findings Rosenbaum and Schutz (1967, p. 52) conclude: "These comparisons reveal that Ps [performers] who carry out the more simple . . . task and are not required to decide among the choices show superior performance. Os [observers] who observe the more complex . . . task and do not decide among the choices also manifest superior performance. It may be suggested then that performing irrelevant responses . . . independent of the decision requirement interferes with acquisition. It also appears that decision making is generally deleterious to acquisition. The general conclusion may be offered that task activities not directly relevant to criterion performance requirements interfere with the learning process."

To test the effect of "strain" on performers, Rosenbaum and Hewitt (1966) administered electric shock to performers on commission of errors in a multiple-choice maze. Observers were exposed to confederates who replicated the performance of performers. The results of this study indicated that performers "suffer interference during the acquisition period that seems not to affect Os. When another factor (electric shock) is introduced to interfere with the performance of Ps, this additional event also seems not to affect Os" (Rosenbaum & Hewitt, p. 82).

The work reported above shows that manipulation of extraneous materials adversely affects learning, as also does the "strain" of decision-making which occurs in performance conditions.

Rosenbaum (1967) and Rosenbaum and Arenson (1968) have consistently confirmed this "observer effect" in learning under conditions and tasks comparable to those initially used by Hillix and Marx. In addition, Rosenbaum (personal communication, 1968) has data indicating that even after 14 trials through his sequential multiple-choice task performers did not approach observers in average proficiency.

Interest in the questions we attempted to answer was further spurred by consideration of the striking improvement in vocabulary, general academic achievement, and I.Q. reported for students in the St. Louis public schools (Spitzer, 1970). Superintendent William J. Kottmeyer conceived the St. Louis Vocabulary Development Project which improved these measures in fourth, fifth, and sixth grades beyond normally expected amounts. Two thousand words from a standard vocabulary list were incorporated into classical literature by rewriting Greek and Roman myths and fables. The stories were read aloud over the school radio system three times each week, with the entire population of school children in these grades reading silently and the teacher writing new words on the blackboard. Test words and pronunciations were written in notebooks and pupils were tested each week.

It would be helpful to educators to know which specific aspect of this program, or combination of aspects, accounted for the remarkable improvement. Since the students at one time or another served both as observers and performers, when was most of the learning taking place?

PLAN OF PROCEDURE

The general plan of the research was, first, to assess the generality of the superiority earlier found for observers, using college students and school children. It was anticipated that this phase of the research would require one year. As it turned out, this was all the time that was available for the experimental research per se, so that much of the further work planned to complete the original project was not done. However, other research beyond that originally planned was carried out, as described in detail below in this report.

The research planned for college students was performed substantially as planned. The first three months of the grant period (summer, 1969) were required for completion of the testing apparatus, as had been specified in the grant application. During this time, also, a pilot study was completed, using summer school college students as subjects. Further studies were then completed during the school year in the laboratory.

The original plans to run experiments on school children in the laboratory were changed, mainly because of some difficulties that arose concerning the transfer of the children from their schools to the laboratory, where the computer-controlled testing equipment was located. The Principal Investigator thereupon endeavored, during the fall months of 1969, to develop new methods for carrying out this research on grade-school children in their normal classroom setting.

Group research on the present problem poses particularly difficult methodological problems in the classroom setting. First, what kind of task can be used which will be interesting to school children but which is not a usual classroom activity to which response habits are already ingrained? This question was answered by developing slides of colored photographs of animals to which children were asked to learn to associate a letter. Second, which kinds of response materials could be easily assembled and transported to the classroom and would give immediate knowledge of results to individual subjects, many of whom make different responses? The materials used were mainly the Rapid Raters and Kolorchek sheets explained more fully in a later section. Since the research had to be completed within one classroom period in order not to disturb the school routine, the task was arranged so that sufficient data could be collected in a single class period.

It was necessary to have assistants in the classroom to aid students in the understanding of unfamiliar stimulus materials and response procedures, and to distribute and collect these response devices. The task had to be relatively uncomplicated in order for the children to understand the instructions in a minimum amount of time. It was necessary also, by instruction, to overcome a resistance on the part of the students to "guessing," and later when they were paired to discourage working together, when individual scores were required.

A detailed description of the response techniques used follows, as well as a brief description of the stimulus techniques and the computer-controlled laboratory booths.

Response Techniques

After extensive preliminary work and consultation with a large number of experts in the education departments of the University of Missouri and Stephens College, three multiple-choice self-scoring devices were tried:

(1) The VVN&N technique, developed and marketed by the Van Valkenburgh, Nooger & Neville Company of New York. This device works by having the responder lightly erase one or more of the circular areas which have been obscured by inking over, to determine whether or not it represents the correct answer for that item. The right or wrong information is printed beneath the obscuration. The main difficulty with this technique is that there is a rather small margin of error in the erasing operation; that is, it requires a certain amount of erasing pressure to insure removal of the obscuring cover but at the same time does not permit too heavy a pressure, lest the answer be removed right along with its cover. Since some children seem to enjoy extremely vigorous erasing, the latter risk was found to be a real one.

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(2) The Rapid Rater, a small pressed-wood device manufactured and marketed by Research Media, Inc., of Syosset, New York. It operates by means of a stylus which the subject used to attempt to penetrate one or more of the numerous holes which appear on the surface board. Penetration of the stylus into the device signals a correct response; failure of the stylus to penetrate signals an incorrect response. An internal template with holes in selected positions programs the sequence of correct responses; and a paper answer sheet placed between the cover and the template receives a permanent record of which holes were attempted by the subject.

(3) The Kolorchek answer sheet, which was developed by the American Guidance Service, Inc., of Circle Pines, Minnesota, at the request of the Principal Investigator. This sheet was adapted by AGS from the techniques used in their reading readiness pamphlets, which utilizes chemically treated answers to indicate the correctness or incorrectness of each answer; correct responses turn green when moistened slightly, incorrect ones turn red.

Both of the latter devices used four response alternatives (A, B, C, and D). Most of the research with the school children was performed with the Kolorchek method, since children not only seem to be strongly motivated to use it, but also it enables an observer to observe easily which answers are attempted by a performer and what the results are in each case; holes punched in the Rapid Rater are a little more difficult for observing children to follow.

Group research with the college students was performed with either the VVNGN technique or, in most cases, with the Rapid Rater.

Stimulus Techniques

Although the response technique, and the feedback (or knowledge of results) problems, constituted the major methodological problem for the group research, considerable effort was also expended on working out appropriate modes of stimulus presentation for the kind of multiple-choice learning task used. After a number of preliminary efforts were made on various kinds of stimulus materials, the use of colored photographs of animals on slides for projection to the group was adopted as the standard stimulus material for the children subjects (and was used in certain cases for college students as well), while various kinds of facial photographs (including facial features selected from whole faces) were used as the main stimulus materials for the college students.

Computer-controlled Booths

In the computer-controlled laboratory booths, all subjects responded to or observed a panel with three keys (one-in. discs that can be illuminated). Stimulus projections on the keys were produced by standard IEE cells (12 separate cells with 4 colors and 8 different line tilts, each cell of which can be separately lighted in the transillumination of the key).

Correct signals consisted of a flashing light signal from a separate bulb placed just above the response keys. Control of the experimental operations was by means of a Honeywell DDP-116 control computer (1.7 microsec. cycle time, 8K core memory) interfaced to the response panels. The decision-making and/or performing subject responded directly to the lighted keys, each with a background color and/or line figure. Observing subjects run at the same time in a different booth were exposed to the same stimulus arrangements and reinforcement operations, yoked by means of parallel wiring from the active panel. In order to identify responses, each time a key was pressed it momentarily blinked as the other keys darkened.

MAJOR ACCOMPLISHMENTS

In the classroom a series of preliminary studies was performed on groups of both college students and grade-school children. The college students were tested either in their normal classroom or in small groups of volunteers from the introductory psychology course at the University of Missouri, Columbia, participating to fulfill part of the normal course requirements. The grade-school children came from all of the fourth, fifth, and sixth-grade classes at the Russell Boulevard School of Columbia, Missouri. A variety of stimulus and response manipulations were tried out during the development of the research techniques. These studies have culminated in the following reports:

A. Marx, M. H., & Marx, K. Observation vs. performance in learning over the fourth to sixth grades. Psychonomic Science, 1970, 21, 199-200.

B. Marx, M. H., & Witter, D. W. Repetition of errors and correct responses as a function of reward and information in human learning. Journal of Experimental Psychology, submitted.

C. Shallenberger, H. D., & Marx, M. H. A comparison of observation and performance in learning with college students. To be submitted for publication.

In the laboratory several studies were carried out utilizing college students in the computer-controlled learning booths. One preliminary study is reported here as well as two final reports published or submitted, as detailed below:

A. Preliminary laboratory study. Decision-making and responding in performance and observation.

B. Witter, D. W., Mueller, J. H., & Marx, M. H. Correction procedures in observational learning. Psychonomic Science, 1971, 22, 94-95.

C. Marx, M. H., Witter, D. W., & Mueller, J. H. Interaction of sex and training method in human multiple-choice learning. Journal of Experimental Social Psychology, submitted.

Reports of these studies have been published or are in preparation for publication in professional journals. They will be reviewed here individually and each will be considered in terms of the results and their implications for future research, both from a theoretical basis and an applied basis. It must be emphasized that even when results of a particular study show statistical reliability it is still necessary to be cautious in translating such results into applied programs. The results of any study apply only to the subjects involved under the conditions as performed, and generalizations of the results can be done only with the utmost caution. At the present time these results do point to specific areas where more research might be fruitful and this will be pointed out in the implications for future research.

Classroom Study in Elementary Schools: Observation vs. performance in learning over the fourth to sixth grades

Purpose. The purpose of this study was to determine the relative efficiency of learning under performance and observation conditions in children from grades 4, 5, and 6.

Method. Permission to do the classroom research was obtained from the administrative officers of the school system, who made the determination of which schools would be used. The principal of the school in consultation with teachers decided which classes would be used. Comments indicated that the classrooms were chosen on the basis of the teacher's general interest in improvement of teaching methods and the teacher's desire to cooperate. The school obtained parental permission for the students to participate. The research problem was explained to all personnel involved and was explained to the students as being a study on how people learn. The major results of the study were reported back to the school personnel.

Typical instructions and a list of the animals whose pictures were used as stimuli in much of the elementary school classroom experimentation are presented in Appendices A, B, and C.

In this study, 140 school children from the fourth, fifth, and sixth grades of Russell Boulevard School, Columbia, Missouri, were trained and tested in a multiple-choice learning situation under both performance (guessing with knowledge of results) and observation (watching the performer) conditions. The task was to learn which letter (A, B, C, or D) had been selected by the experimenter to associate with each of the animals whose picture was shown on the screen. The response to each picture was to record the letter guessed on a Rapid Rater. The stylus would enter the hole up to the hilt when an answer was correct, giving immediate knowledge of results. Subjects were paired by sex and ability. For the presentation of the first half of the pictures the odd-numbered member of the pair performed, while the even numbered observed. For the second half of the items the role was reversed. Then a test trial was given, which consisted of presentation of all of the animals again, in different order, with subjects responding by writing what they thought the correct answer to be on a numbered sheet. This procedure was repeated four times, thus providing four training trials and four test trials.

Results. The results are summarized in Table 1. Two statistical analyses were performed, a chi-square test and, as a check, a simple t-test. Both tests showed the difference to be reliable at just beyond the .05 level of confidence.

Table 1

Number of Subjects in Each Grade with More Observation Items Learned (O > P), More Performance Items Learned (P > O), and Equal Numbers of Items Learned (O = P)

	Grade 4	Grade 5	Grade 6
O > P	15	9	24
P > O	29	22	19
O = P	3	11	8
N	47	42	51

Interpretation. These results demonstrate a shift in relative efficiency of learning from the performance to the observation condition between the fourth and sixth grades. Although the sixth-grade students surpassed the fourth-grade students on observation learning scores, they did not show an actual superiority of observation to performance condition.

Theoretical implications. Since these results are inconsistent with the data on children reported by Rosenbaum (1967), who found consistent observer superiority, some possibilities which might account for the difference in results need to be co[illegible]dered. First, the difference may be due to the procedures used: Rosenbaum's subjects had a more difficult response requirement, and a correction procedure was used allowing three trials to find each correct response. More importantly, perhaps, the present task involved the learning of a series of relatively discrete stimulus response items occurring in a different order on each trial. Rosenbaum's task, like the original Hillix and Marx (1960) task, was essentially a serial one in which successive correct responses were made in the same spatial relationship to each other, thus enabling the subject to use such cues in learning. It appears that observers can benefit more from such cues, presumably because they are in a better position to keep the earlier responses in mind, as through rehearsal, and are not distracted by such functions as deciding which response to make, actually making the response and the like.

[illegible] shift to a greater proportion of "observation learners" at the h[illegible]r age level of sixth grade may be most simply explained by the increased maturity of the students, which enabled them to cope more effectively with the unusual observation procedure. The experimenters noticed that some of the fourth-grade observers did not always watch their partners perform.

Educational implications. The shift in proportion of those [illegible]o learn most effectively by observation suggests that further research be done on which kinds of classroom tasks could be best learned by observation. For example, are there some rote memory kinds of learning required for mastery of subjects such as mathematics, spelling, or foreign language, which could be more efficiently taught by using methods which include observation as children mature? Would it be possible to teach concept formation in this way as well? Here a suggestive result was obtained by Chalmers (1964, cited in Rosenbaum and Arenson, 1968), who found that errors (irrelevant responses) were less often continued by observers in conceptual learning.

Other basic questions are raised by these considerations. For example, whether the observer is an "imitator" or receives beneficial effects from "vicarious reinforcement" is important for educators to consider in the types of materials which are presented by means of television and movies. As an example, one need look no further than some popular television shows which have contestants doing a variety of things, answering questions, guessing, and receiving prizes for best performances. Certainly the television audience is participating vicariously and such techniques may be efficient in the classroom as well.

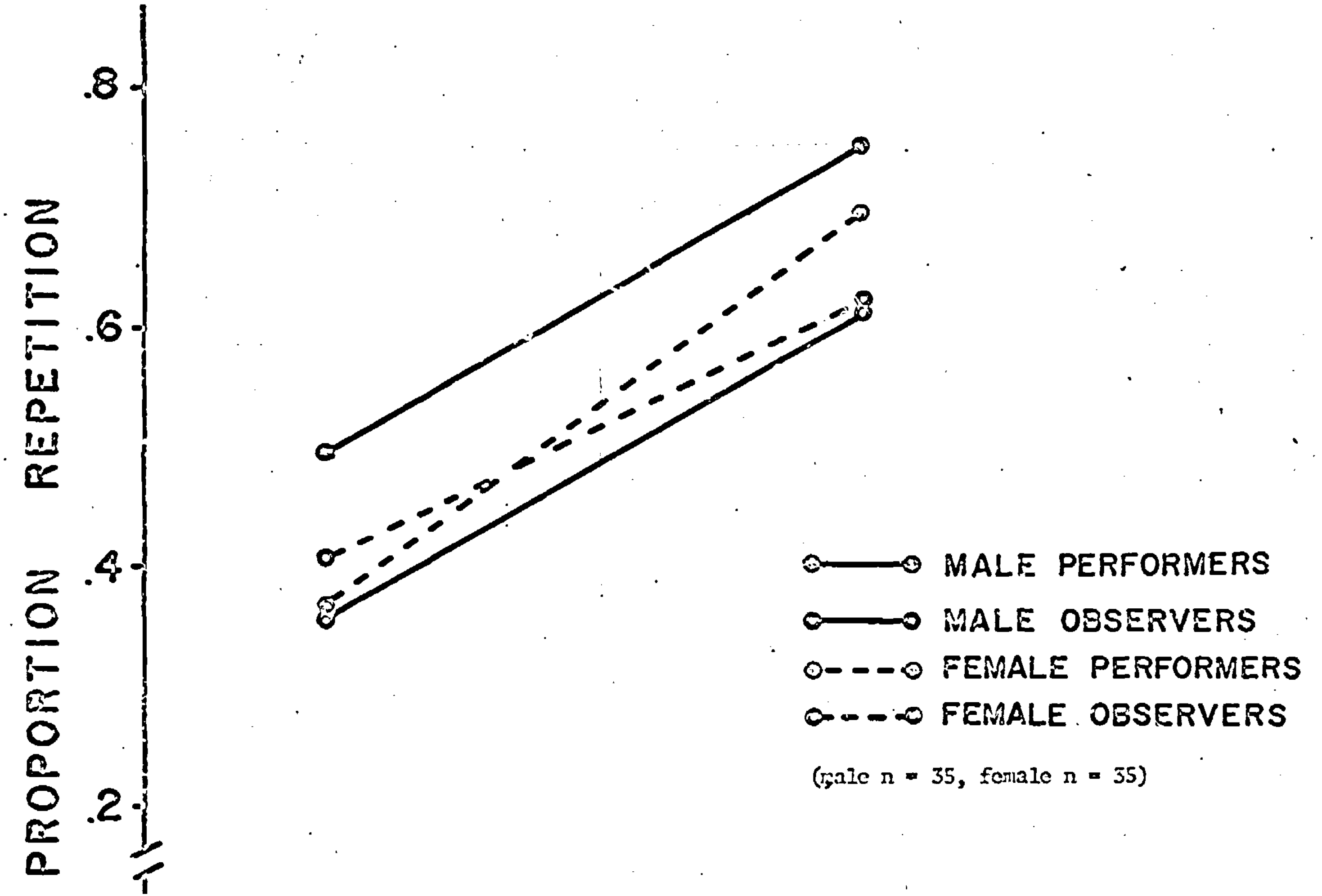
Classroom Study with College Students: Repetition of errors and correct responses as a function of reward and information in human learning

Purpose. This study was designed to determine whether there are any important differences in the tendency to repeat errors and/or correct responses as a function of reward (performer condition) or information (observer condition).

Method. The subjects were college students who volunteered with the understanding that their participation would earn extra credit for them in their introductory psychology course. The task was to associate letters (A, B, C, or D) with facial features (eyes, nose, chin and mouth, forehead, and a name) presented on the screen. Each subject served alternately as a performer and as an observer. Each training trial consisted of the presentation of 40 facial features, 20 for each subject serving as a performer and 20 for each subject serving as an observer. Responses were made by means of the Rapid Rater described in detail earlier. After each presentation of the 40 features, a retention test was administered by means of paper and pencil, and all subjects responded to all of the 40 features presented again in a different order. Four trials were completed.

The subjects were placed in pairs as they entered the classroom, females being paired together and males paired together. In addition, subjects in another group worked under an "individual" condition where they were given access to recorded information regarding the responses of another subject (one who had previously performed in the social condition).

Results. The results for 35 male and 35 female subjects are presented in Figures 1 and 2. Analysis of the correct responses showed that male performers were consistently superior at repeating responses which were correct on training trials on test trials. The analysis of variance of


PROPORTION REPETITION
.8
.6
.4
.2
MALE PERFORMERS
MALE OBSERVERS
FEMALE PERFORMERS
FEMALE OBSERVERS
(male n = 35, female n = 35)

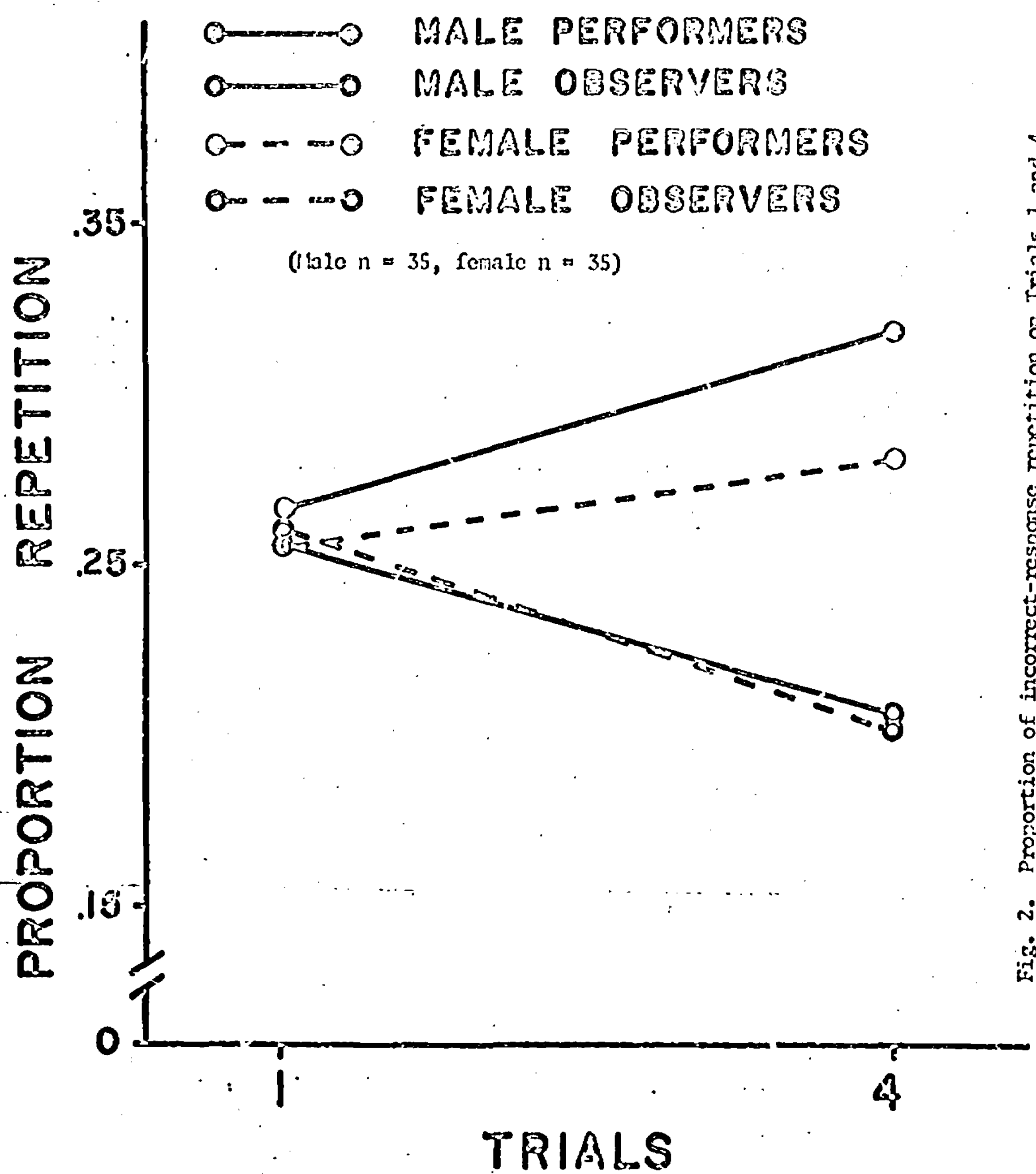


Fig. 2. Proportion of incorrect-response repetition on Trials 1 and 4.

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these data indicated reliability for the main effects of reward ($F = 5.44$, $p < .025$ for 1, 68 df) and trials ($F = 71.38$, $p < .01$ for 1, 68 df) and the interaction of sex and reward conditions ($F = 4.93$, $p < .05$ for 1, 68 df).

Analysis of errors showed a very different picture. Both sets of performers showed a marked increase in the tendency to repeat errors, while both sets of observers showed a marked reduction in this tendency. These results were statistically reliable. The main effect of reward was reliable ($F = 8.52$, $p < .01$ for 1, 68 df) as was the interaction of reward and trials ($F = 6.94$, $p < .01$ for 1, 68 df). Although the male performers tended to repeat errors more than the female performers, this sex difference was not reliable ($F < 1.00$).

Theoretical implications. These results point up the difficulty of analyzing even the simplest learning task. They apparently contradict the earlier results reported by Hillix and Marx and Rosenbaum. It again appears that one determinant of observer or performer superiority may be the type of task used. The experiment reported here utilized discrete stimulus-response units, the earlier Hillix and Marx experiment as well as the Rosenbaum task involved sequential operations. It should be noted also that the Marx and Marx learning task used in the elementary-school classroom research involved discrete stimulus-response units.

The contrasting results for correct responses and errors found in the present experiment as a function of performance or observation suggest that one's own responses produce somehow greater strength, on later training trials at least, than some one else's responses which are merely observed. These results also are consistent with the finding (cf. Marx, 1971) that the more often errors are repeated the more likely they are to recur over trials. Neither of these related phenomena can be readily explained on the basis of differential pre-experimental error strength because of their failure to occur on the initial training trials.

Educational implications. Implications for educational practice focus on two areas of concern--the insurance of performance only of correct responses and the earliest possible elimination of performance of errors. Definitive practical methods cannot be devised without first a complete understanding of the task involved. The most well-known attempt at practical application of these principles was developed by Skinner (1954, 1959) and le to the further development of programmed learning. In a discussion of this development and other educational reforms, Marx and Tombaugh (1967) point out advantages and disadvantages of various types and conclude (p. 236) that "the programmed-learning movement has been of great value in forcing a careful evaluation and reworking both of educational objectives and of the content and organization of education materials."

No systematic attempt has yet been made to determine what aspects of a task can be more efficiently learned by observation. This is an important problem for future research. The results reported here would indicate that in tasks where many errors are commonly made observer techniques could be developed as teaching methods. The significance of the training program is underscored by the strong suggestion, mentioned above, that the increased tendency to repeat errors under performance cannot be interpreted simply as a function of differential pre-experimental strength of those errors.

Classroom Study with College Students: Acquisition and Retention under Observation and Performance

Purpose. Two experiments were performed with college students as subjects in another effort to replicate the observer superiority found earlier. The experiments were designed to use a more meaningful task, learning the occupations of prominent persons whose photographs were shown on a projection screen, than that involved in most of the other studies.

Method. In Experiment I, students in the Psychology 20 class of Mr. Hugh Shallenberger participated in the experiment, working in pairs. Half of these subjects first performed on 10 multiple-choice items, with the other half observing, and the relationship within each pair was then reversed for the second set of 10 items. The stimuli were slides of photographs of prominent persons, and the responses required were guesses of the occupation of each person (scientist, politician, musician, or writer). The VVN&N self-scoring sheets were used on training trials, as described above. Two acquisition tests, using machine-scored test sheets, were given, one after each training trial.

Experiment II duplicated Experiment I with two important exceptions: (1) Because the results of Experiment I suggested some inequality in difficulty between the two sets of items, although they had been randomly selected, items were now regrouped on the basis of the number of errors made to each in Experiment I. From each pair of successive items (that is, the two most difficult, the two next most difficult, etc.), one item was now randomly selected for each set, in an effort to equate set difficulty on an empirical basis; (2) a retention test was included, after a one-month interval, in order to determine whether there was any change in response strength over time as a function of the observation/performance variable.

Results. The results for Experiment I are shown in Figure 3. It is evident that the order variable interacted with the observation/performance variable, so that for each order the second condition was superior on test. That is, the subjects who performed first, then observed, learned more under observation, whereas the subjects who observed first, then performed, learned more under performance. In each case, the observation/performance difference was statistically reliable: $F = 329.90$, $p < .01$ and $F = 23.86$, $p < .01$ for 1, 192 df, for perform-observe and observe-perform orders respectively.

The results for Experiment II were very similar, as shown in Figure 4. Again an interaction occurred, in the same direction, between the order and observation/performance variables. Again, also, both differences were statistically reliable: $F = 14.31$, $p < .01$ and $F = 6.51$, $p < .05$, for 1, 80 df, for perform-observe and observe-perform orders respectively.

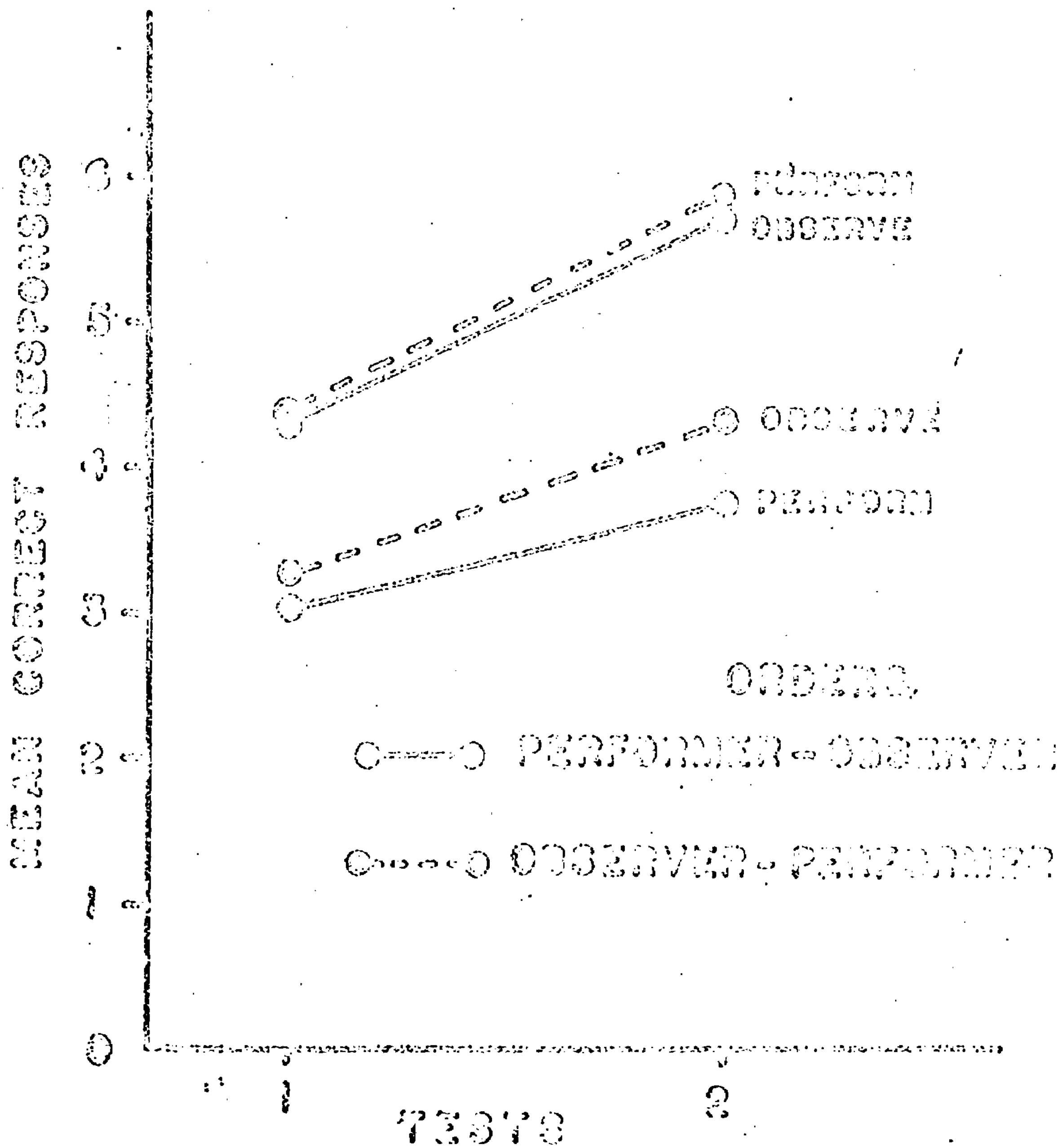


Figure 3. Results of Experiment I.

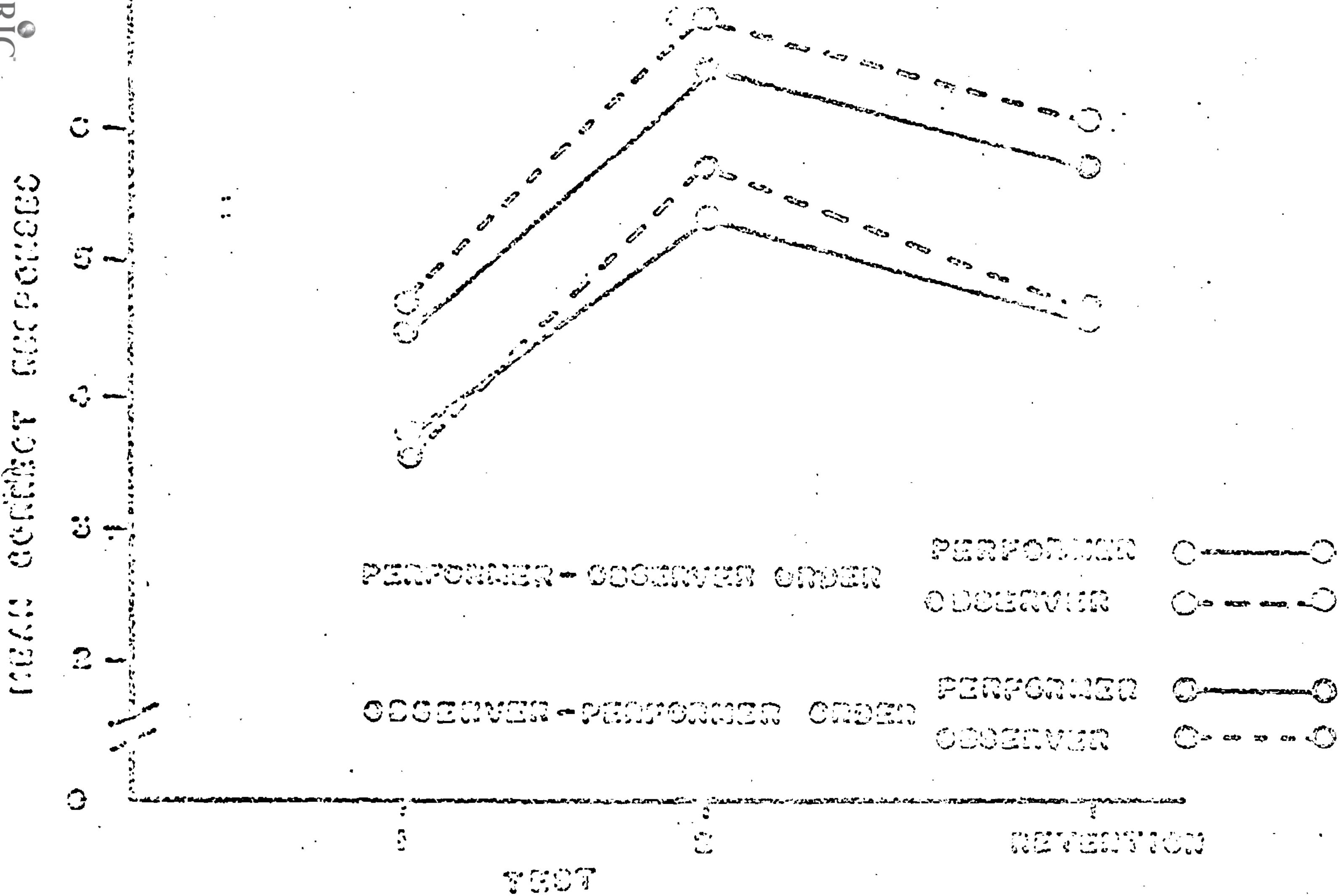


Figure 4. Results of Experiment II.

Interpretation: Theoretical Implications. Theoretical implications are difficult to ascertain, in view of the fact that control in Experiment II of set-difficulty differences, suspected from the results of Experiment I, did not change the interaction of the order and observation/performance variables. Thus we are forced to conclude, on the basis of these data, that whether one observes or performs first determines which learning technique is superior. The implication is that learning to learn, in the present situation, is an especially powerful factor, and one that must be considered in future research of this kind. But no very meaningful conclusion can be drawn concerning any general superiority of either observation or performance. The fact that in both experiments observation superiority was somewhat greater than performance may simply reflect the interfering role of the erasure responses required of the performer; as Rosenbaum and Schutz (1967) have shown, the more extensive the set of responses required of the performer the greater the observer superiority.

The fact that retention scores followed closely the direction of the acquisition tests in Experiment II does not support the proposition that there is an interaction between type of test (here, acquisition and retention) and the observation and performance variable, as suggested by the Hillix and Marx (1960) results on acquisition and transfer.

Educational implications. As indicated above, these data seem to implicate a learning to learn factor, or perhaps a warm-up factor, as an important consideration in this kind of learning. That is, the experience of either observing or performing on the first half of the items seems to improve whichever learning function comes next. The implication, then, is that educators need to be sure that sufficient practice, or warm-up, is provided before critical items to be learned are presented to students, if optimal learning is to be obtained.

Laboratory Study with College Students: Decision-making and responding in Performance and Observation

Purpose. This experiment was performed at the initiation of the research project. Although the observation/performance variable was manipulated along with a decision-making/nondecision-making variable, the experiment's primary function was intended to be methodological, enabling us to evaluate and adjust the procedures in this newly developed apparatus. For this reason the present description emphasizes methodological considerations.

Method. The procedural details for this first experiment are summarized in Appendix D. Briefly, the apparatus utilized consisted of computer-controlled booths, each with a panel containing three one-in. discs ("keys"), transilluminated by standard IEE cells for visual stimulus display, and a response button placed beneath each disc; printed test forms; and questionnaires.

The experimental design was a simple 2 by 2 factorial in which perform/observe and decide/no-decide were manipulated. Thus, under the four basic experimental conditions each subject (1) decided and performed (D/P), (2) decided but did not perform (D/NP); (3) did not decide but did perform (ND/P); (4) neither decided nor performed (ND/NP). Since the subjects always served in pairs within the same booth, when one subject performed, whether or not he also decided which response to perform, the other subject of the pair at that time necessarily did not perform (but merely observed).

As described in detail in Appendix D, the task consisted of learning which of three tilted-line patterns in each of 16 such triads was correct.

Results. One of the four sets of subjects (that is, one of the four orders in which subjects were run through the four basic experimental conditions) unfortunately produced consistently higher learning scores regardless of condition. This fact complicated the interpretation of the between-groups data, and although statistical analyses were performed and some reliability of differences achieved, these were inconsistent and do not justify serious consideration. Improvement over successive weeks, however, was generally evident, and there was a suggestion that the slowest learning may have occurred under the D/P condition, in which the same subject both decided and performed.

The results of the formal questionnaire were suggestive, and the questionnaire with a summary of these results is presented in Appendix E. Also, the instructions given the subjects during the experiment and the final feedback to them are presented in Appendix F and Appendix G.

More interesting was the spontaneous feedback received by the experimenter from the subjects during the progress of and after the experiment. These comments are therefore summarized here, because apart from the technical (procedural) adjustments which the experiment made possible they probably represent the most valuable outcome.

Spontaneous feedback. In general terms, many subjects felt they had achieved learning (within the acquisition phase) partly through "osmosis" or a kind of unconscious learning; they would find they improved without being aware of knowing the correct responses. Some looked for a pattern in the stimuli, but the more common response was perception of the stimuli as being less systematic than was actually the case. Many subjects thought that each set of trials had been different (whereas they were identical except for the order of presentation), and some felt that the order (left-center-right) of designs in certain triads changed from one trial to the next, or even that the one which was correct changed (whereas both of these factors remained the same throughout for each triad).

In terms of persistence of errors, some subjects stated that they felt they became "hung up" on the same errors, pressing or deciding (in the case of D/NP) on the same incorrect response for a triad each time it appeared. On the other hand, in cases where the correct response happened to be easily remembered, they would learn it early in the run and be able to "rely" on it for at least one correct R. (An extreme example would be a correct one-line design presented with two 4 to 7-line designs.)

Many subjects felt the ND/P condition was most difficult, principally because they often knew the correct answer when the decider would choose another one, with a resulting urge to press the correct button anyway.

Despite the data showing improvement over tests, many subjects subjectively perceived their performance as improving to the second block, then diminishing with blocks 3 and 4; this was ascribed to confusion, fatigue, and boredom in most cases. Some subjects also said they would have preferred more successive repetitions of trials without pauses to achieve more continuity and better performance during acquisition.

The most common complaint, however, was that the printed recall tests were not similar enough visually to the triads as presented during acquisition for transfer of learning to be readily achieved. This effect consisted mostly of the black-white reversal, and the difference in thickness of lines. The IEE cells had the quality of occasionally presenting lines of slightly varying intensities; they may also appear to overlap, and this evidently formed a set of cues for many subjects which was not repeated on the printed tests.

Interpretation. The methodological difficulties encountered in this first study prevented the drawing of any firm conclusions concerning the role of decision-making vs. overt responding. In the light of the non-appearance of consistent observer superiority in our subsequent studies this problem was not attacked again during the project. However, it remains an important consideration and should be included in any future research on such related problems as which task characteristics favor observational or performance learning.

Laboratory Study with College Students: Correction Procedures in Observational Learning

Purpose. This study concerned the effect of various informative feedback procedures on learning under performance and observation conditions. Our initial interest in this problem was again largely methodological, deriving from the rather ambiguous results in the laboratory with regard to the relative retention of observers and performers. Most typically, studies in this area have used a specific correction procedure, with the subject being immediately shown the correct response in the event of an error. Other methods might include mere outcome correction, with the subject not being shown the specific correct response after an error, and a correction discovery procedure whereby the subject continues to respond until he finds the correct response each time. The present question of interest was whether observation is more effective under one arrangement than under the others.

Although this experiment was primarily a methodological investigation, there are at least two grounds for believing that the feedback procedure might affect observational learning differently than actual performance learning. First, there is the issue of proprioceptive feedback (e.g., Adams, 1968). To the extent that some of a learner's feedback is proprioceptive, the possible correction techniques would provide such feedback differentially, as would observation as opposed to performance. Furthermore, it is possible to distinguish between a learner's memory for a response and his memory for the outcome of that response in a given situation (e.g., Buchwald, 1969). It seems that these two memories might be differentially involved when one is performing as opposed to when he is observing someone else. For example, an observing subject may have preferred another response on a given occasion, so that on the subsequent repetition of the stimulus the observer may be confused as to whether his preference or the performer's choice produced a given outcome, whereas the performer would experience less such conflict.

Although these comments might seem more applicable to the observational learning situation, they can be applied to the modeling procedure (Flanders, 1968) as well. The purpose of the present experiment was thus to investigate observational learning as a function of feedback, to extend its generality, and to help to illuminate its differences from performance.

Method. One hundred and twenty students from introductory psychology courses participated in fulfillment of course requirements. The overall design may be summarized as a 2 x 2 x 3 factorial, with sex, performance condition (observe, perform), and feedback condition (outcome, discovery, specific) as between-subjects factors, with 10 subjects per cell.

Apparatus. The subjects were run in booths equipped with a display panel and shelf desks to write on during tests. The front panel had three 1-in. display discs in a horizontal row 4 in. apart, with response buttons directly below each cell to be used by the subject to indicate his choice. Each cell displayed up to eight tilted lines (22½° differences), and the colors red or green when required. The cells were controlled by a Honeywell DDP-116 computer, which displayed the stimulus patterns in predetermined orders, recorded the responses of the performing subject, and provided response-contingent feedback according to one of the three treatments.

Stimulus materials. As in the first laboratory study, described above, line-tilt patterns were used as the stimuli, including patterns with from one to seven lines. Three sets of 36 designs each were used. Each set was arranged in 12 triads. No designs of the same complexity (in number of lines) were placed in the same triad, and complexity per se was not consistently related to correctness. The triads in each set were then arranged in different orders for presentation on successive trials through the set, with an equal number of correct responses in the left, center, and right spatial positions on the display panel, and no more than two consecutive correct designs appearing in the same spatial position. The subject's task was to learn which design in each of the 12 triads in a set had been arbitrarily designated as correct.

Familiarization. In a familiarization session, prior to the experiment proper, the subjects were given instructions and training for the task and for their particular performance role. Instructions were played over an intercom in the booth from a tape recorder, describing the roles of the observer and performer. The subjects were run as pairs, but were isolated in different booths. The performer selected which of the designs he wanted from each triad, and the appropriate type of feedback was delivered. The observer was not allowed to select any design during the study phases, but was only shown the performer's choice and its outcome, with the booths yoked through the computer for this purpose.

The display panels were explained and subjects were shown a sample set of triads. The task for the performer was to attempt to choose the correct design in each triad. He then received one of the three varieties of informative feedback, with the paired observer seeing both the choice and feedback in real time in his booth. The sample had eight triads shown for two study trials, followed by a paper and pencil test for both observer and performer. During this test, the triads were shown on the display booth in both panels, with both subjects checking a piece of paper for left, center, and right as their choices, and with no feedback given. Two more study trials and another test concluded familiarization. The subjects were thus acquainted with their performance role, feedback condition, and general task procedures.

Experimental sessions. The experiment proper used sets of 12 triads. Whereas familiarization involved blocks of two study trials separated by tests, the main experimental session used blocks of three study trials before a test trial. Eight blocks of three study trials followed by a test were used.

Feedback. Three different feedback conditions were used, the primary difference consisting of how the error response was treated. These differences were of course effective only for the study trials, with no information given on the test trials. In all cases, the yoked observer saw all the choices and the feedback on his own panel. The responding was essentially self-paced, but with a ten-sec. limit per triad, and a three-sec. intertriad interval.

With outcome-correction, an error was simply followed by a red light superimposed on the pattern chosen. The next triad then appeared after 2 sec. If the response was correct, a green light was superimposed on the design for 2 sec. On an error trial, these subjects did not know which of the two remaining designs was correct.

With discovery-correction, the performer was allowed a second choice on an error trial, and a third if necessary, to find the correct response. Thus he could make as many as three responses to each triad, and both subjects were shown which design was correct before the next triad appeared.

A correct choice in the two conditions described above always led to a green light appearing over the design chosen. In specific-correction, however, this also occurred on the error choices. That is, if an error occurred, the green light simply came on over another design, the correct one. The performer was only allowed one response per triad.

Results. The data from the paper and pencil tests were used in a 2 x 2 x 3 x 8 mixed analysis of variance, adding trials to the previously noted design as a within-subjects factor. Table 2 presents the group means for these data. Analysis of the number correct revealed no reliable main effects for either Sex or Performance (Fs < 1). Feedback condition was significant, with outcome-correction reliably less effective than specific-correction or discovery-correction [F (2, 108) = 8.79, $p < .01$], and no difference between SC and DC.

Table 2

Mean Number of Correct Responses Pooled over Test Trials by Sex, Performance Condition, and Feedback Condition

	Men		Women	
Feedback	Observe	Perform	Observe	Perform
Outcome	7.41	7.16	7.15	7.50
Discovery	8.94	8.40	8.98	8.61
Specific	8.58	9.44	8.38	8.89

Of somewhat greater theoretical interest was the finding of statistically reliable interactions of both sex and performance/observation factors with trials [F (7, 756) = 2.52, $p < .05$, and F (7, 756) = 2.28, $p < .05$, for the sex by trials and observation/performance by trials interactions, respectively]. These interactions are shown in Figures 5 and 6.

As Figure 5 shows, female students were inferior to male students in the early trials but superior in the later trials. This shift may reflect a greater initial degree of unfamiliarity with and/or aversion to the geometric type of stimuli in females, and the subsequent adaptation to them over the later trials.

Little consistent difference in performance/observation scores occurred in the early trials, as Figure 6 indicates but some degree of superiority developed for the performance condition over the later trials.

Interpretation: Theoretical implications. Although the primary intent of this experiment, and an earlier preliminary one which was run under similar conditions (and is not described in this report), was methodolological, the results do have certain theoretical implications. On the basis of the present data, there seems to be no reason to expect the comparability of observational and performance learning to be limited to any one of the types of feedback used in this study. Some difference might arise with faster presentation rates or learning to a more stringent criterion (80% correct performance was obtained on the average, after the 24 study trials and 8 test trials).

Nevertheless, there was no suggestion of a difference with slow rates of presentation, and, in so far as correction-induced processes are concerned, observational learning appears to be comparable to performance.

Educational implications. The most suggestive result obtained in this experiment concerns the interaction of sex and trials. If the interpretation suggested above, that adaptation to unfamiliar and perhaps aversive stimulus materials occurs over trials for females, then there is the clear implication that educators need to take great care that girls are allowed sufficient practice on such types of materials. It is possible that this conclusion can be enlarged to include both sexes when learning of unfamiliar and aversive stimulus-response associations is concerned.

Laboratory Studies: Interaction of Sex and Training Method in Human Multiple-Choice Learning.

Purpose. In the present experiment two variables were manipulated: observation vs. performance and social vs. isolate training. The social variable was chosen to determine the feasibility of using isolate pairs in an observational learning situation. The isolate condition served as a control for the factor of social interaction, eliminating the usual "modeling" aspect (cf. Flanders, 1968) affecting the social observer; there is also, of course, the possibility that the performer may be affected by the social variable. With regard to the "modeling" aspect, the present situation differed from the customary one in that the performer was not a confederate; his responses were determined by the experimental situation rather than by the experimental design. The factor of sex was also taken into account by using like-sex pairs in all cases.

Fig. 5. Interaction of Sex and Trials Factors.

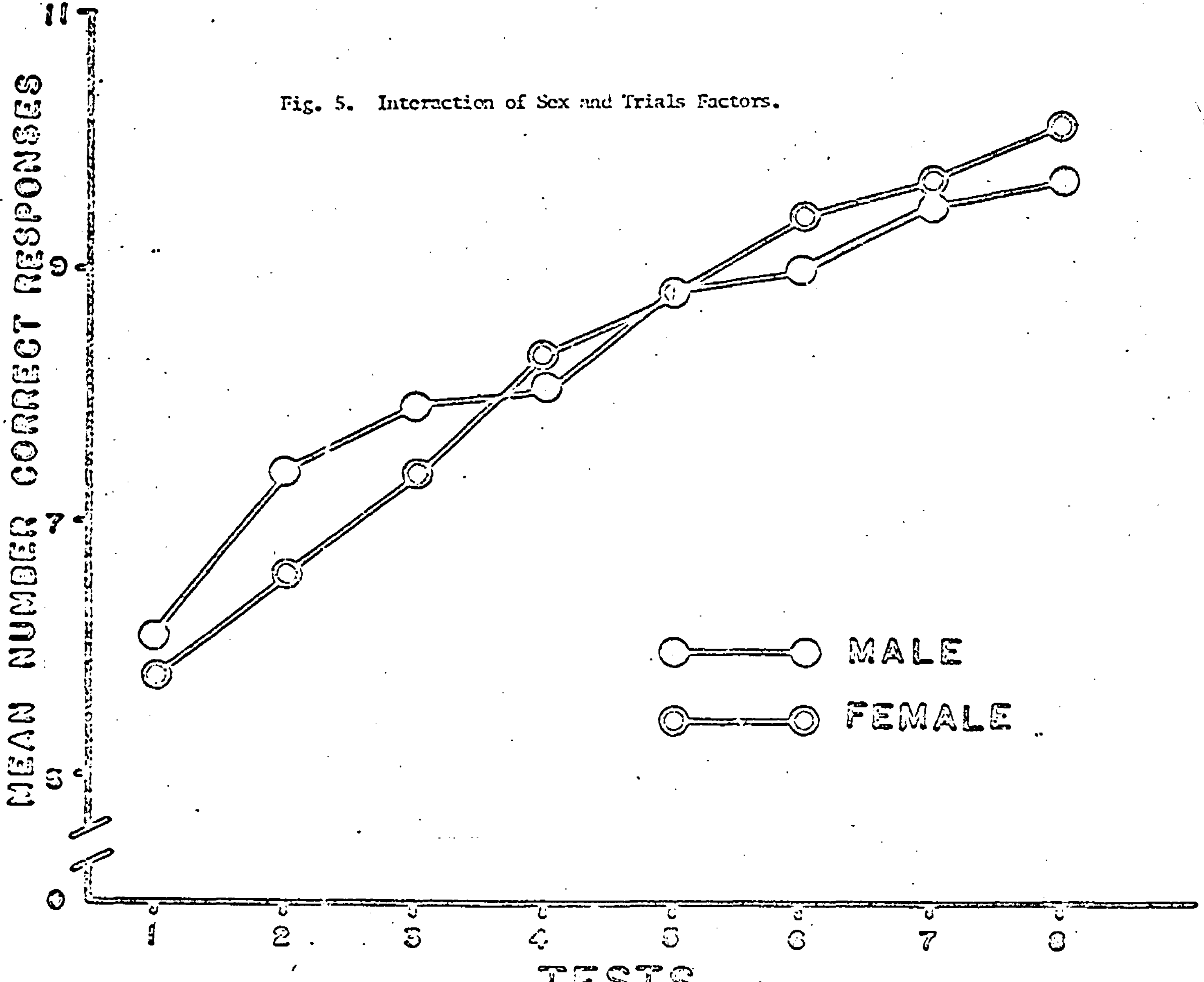
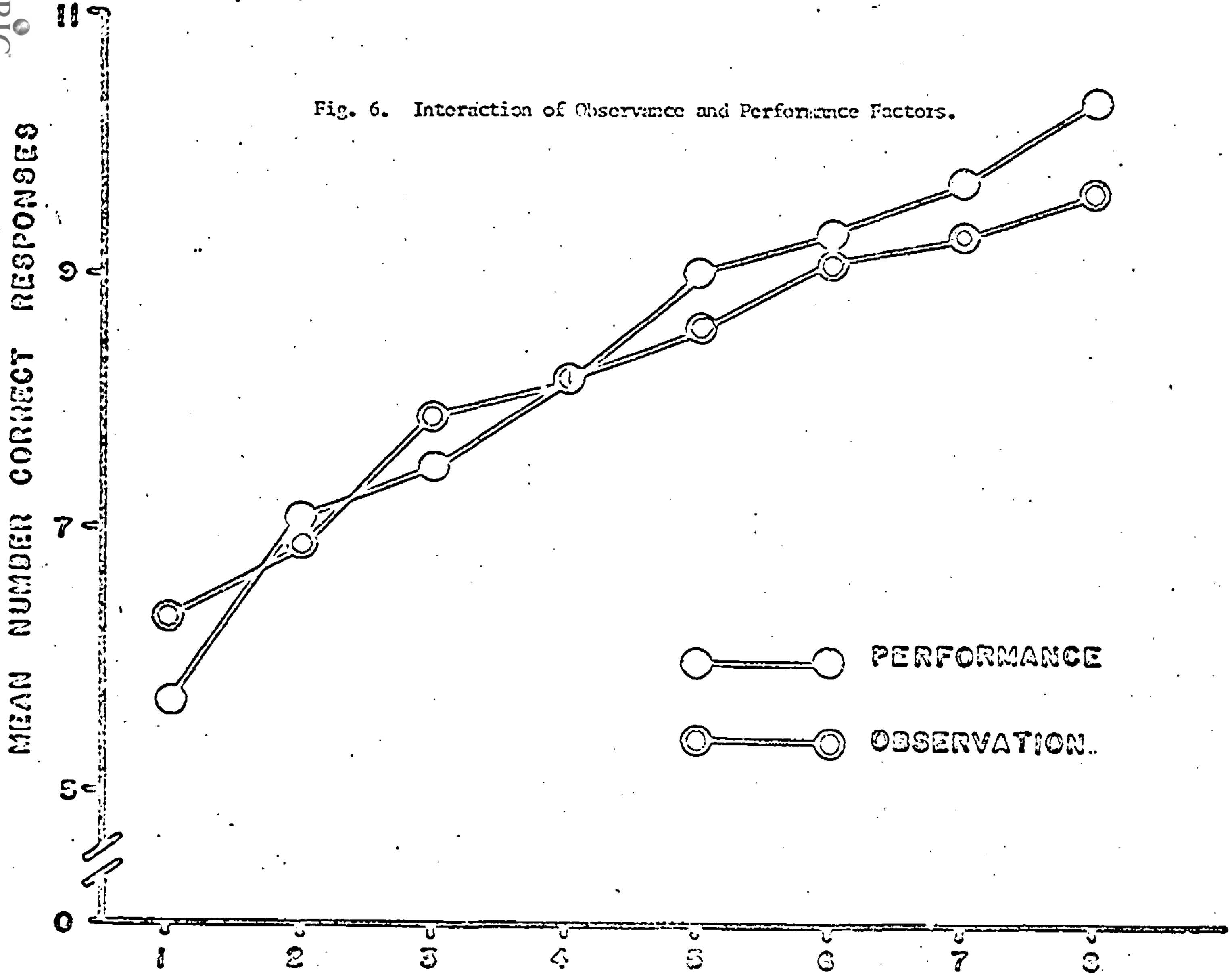


Fig. 6. Interaction of Observance and Performance Factors.



Method. All subjects were given a familiarization session the week before the training-test session. They were shown the apparatus and general procedure, with sample stimuli, but were not told into which group they would be placed. The apparatus consisted of four computer-controlled operant booths, each of which contained a display panel with the three one-inch keys on which various patterns of tilted lines (at 22.5° variations) were shown by means of standard IEE cells. The two active booths, for performing, contained response buttons beneath each key, permitting selection of one stimulus. The two inactive booths had no response buttons, but each was yoked to one of the active booths so that exactly the same display of tilted-line patterns appeared simultaneously in the two booths, and a brief blinking of the pattern selected by the performer (by pushing the button) indicated such selection to the isolated observer.

The 124 subjects were randomly placed into one of the four groups; the factor of sex then yielded a simple 2 x 2 x 2 factorial design (observe/perform by social/isolate by male/female). To get equal ns, 28 subjects were randomly discarded, yielding 12 in each of the eight groups. Social performers and observers were placed together in the same active booth; isolate performers and observers worked by themselves in two separate but yoked booths, as described above.

The same sixteen sets of 3 line-tilt patterns (triads) with one to seven lines per pattern, as had been used in the earlier research, were used as stimuli. The triads were presented for three blocks of three trials each, with a paper-and-pencil retention test following each block of trials. One pattern from each such triad was randomly selected as correct. The task required the correct pattern to be discovered by the performer, and remembered by both the performer and the observer. A non-correction procedure was used; i.e., a single response was permitted for each stimulus triad. Stimuli appeared at the rate of one triad for 10 sec., with a 3-sec. intertriad interval.

Results. The main effects of observation vs. performance and social vs. isolate condition did not produce statistically reliable differences in terms of number of correct test responses. However, there was a reliable main effect of sex, with males surpassing females (means of 7.27 and 6.67 correct responses out of 16, respectively; $F = 4.09$, $p < .05$ for 1, 88 df). Moreover, and most interesting, there was a reliable triple interaction between sex, social condition, and tests ($F = 4.81$, $p < .01$ for 2, 176 df), as shown in Figure 7, with social females showing markedly less improvement over test trials under either performance or observation conditions of practice.

Interpretation: Theoretical implications. The superiority of males in this particular task may again in part reflect their greater familiarity with and/or lesser antipathy toward the geometric type of stimulus. As mentioned earlier, however, in other recent research in this laboratory, we have observed male performer superiority in repeating correct responses, using a quite different kind of stimulus material (human facial features). This fact suggests the generality of male superiority, especially under the performance condition, and indicates that the sex variable needs to be considered in future research on these problems.

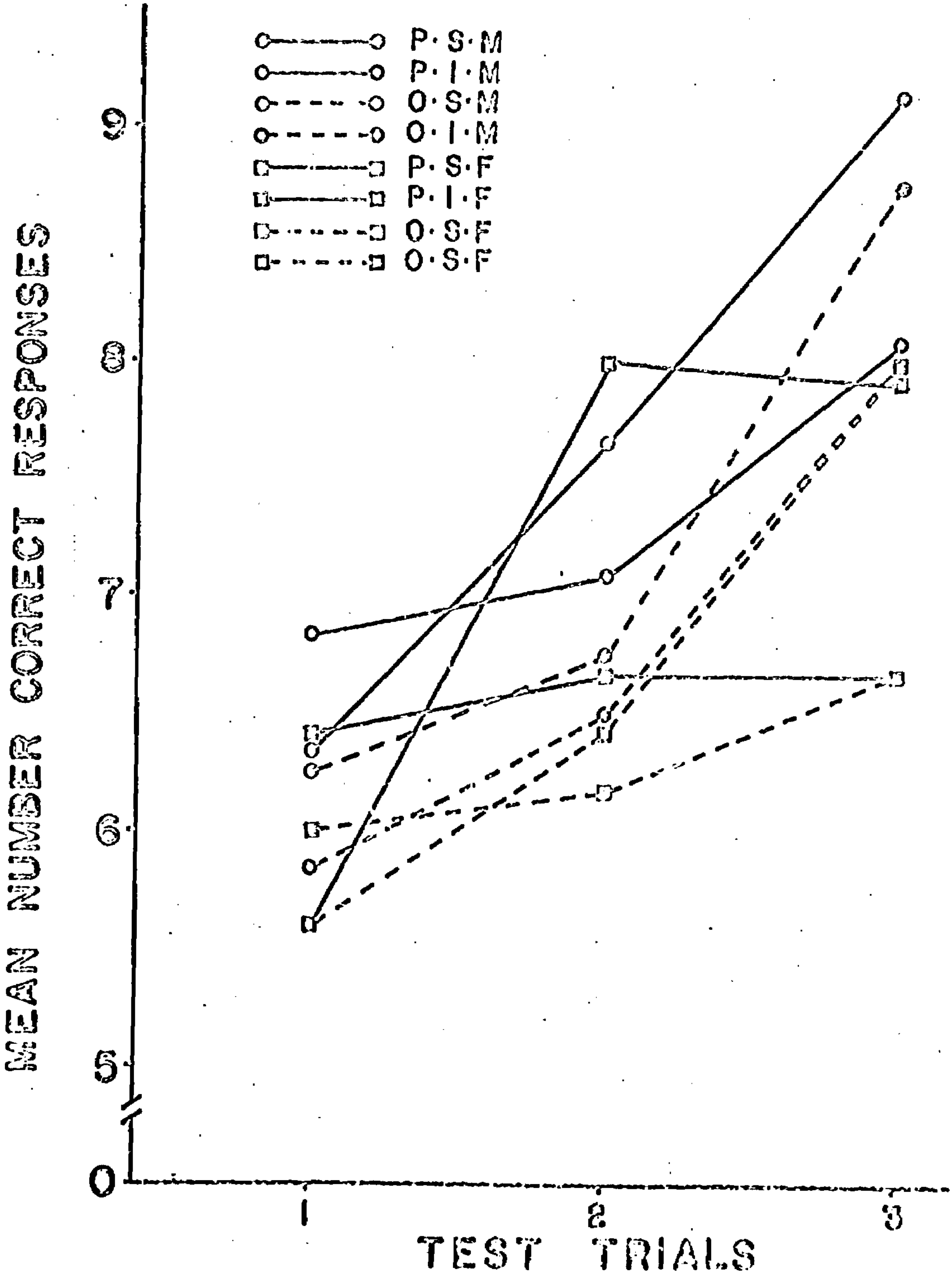


Fig. 7. Mean number correct responses over trials. Variables: observe/perform (O,P), social/isolate (S/I), and sex (M, F).

The unexpected but interesting triple interaction offers food for a diversity of theoretical thought. As one possibility, it may be that the anxiety level of women working socially is higher than that of men working socially, and that their learning of such relatively unfamiliar materials is thereby retarded. This kind of interaction did not occur in the other study, in which the social pairings were done within a classroom rather than a booth in which only the two subjects were present, suggesting the specificity of the effect to the present kind of social condition.

An alternative interpretation that minimizes sex as an effective variable in this triple interaction is also possible. This interpretation is suggested by data reported by Cottrell (1968) in his comprehensive recent review of audience effects upon human performance. He found a triple interaction among the variables of audience, nature of task, and speed of learning. Slow and medium-speed learners made more errors in a competitive list (pre-experimental associations interfering with responses to be learned) and less errors in a noncompetitive list with an audience (passively observing) present. No differences were found for the faster learners, and only males were used as subjects. These results are consistent with Zajonc's (1965, 1966) hypothesis that dominant responses, whether correct or not, are generally enhanced by the anxiety-arousal produced by the social presence of others. In the present case, if we assume the female students were slow learners, on the basis of the nature of the task used, their failure to show much improvement over trials in the social condition could be explained by the further assumption of greater anxiety arousal (Spence, 1956). Since this failure was found for observers as well as performers, it appears that observational learning as well as the more active performance was affected. But the greater frequency of errors, because of the unfamiliar materials rather than sex per se, would account for the slow learning of the women by this account.

Educational implications. The reliable sex difference found here and in other studies suggests that some consideration should be given to such a difference in the classroom. It is possible that this sex difference interacts with the type of task used, but since the difference was also found in the facial task it may also be that it is more pervasive and not restricted to tasks.

For a related example, Nuttin (personal communication, 1970) has recently found in several experiments in his laboratory that male students consistently overestimate the 50 per cent degree of actual success they have following their observation of very high degrees of learning success in others, whereas female students show exactly the opposite tendency.

The effect of anxiety on learning has both theoretical and educational implications. Did anxiety play a part in the failure of women to improve in acquisition over trials under social pairing conditions? In the light of Rosenbaum and Hewitt's (1966) experiment, where electric shock had deleterious effects on acquisition, this could have been an important factor.

Sarason (1960) found that most studies dealing with task complexity demonstrate that as task complexity increases high-anxiety subjects progressively perform at a lower level. Such anxiety in complex tasks could be important in explaining the differences in the results of various observe/perform studies. In the Hillix and Marx (1960) study, for example, the subjects reported feeling "strain" under performance conditions. This task, in which observers excelled, was more complex than those reported here in which performer superiority appeared.

Some methodological suggestions should also be noted. Not only would it seem that caution is indicated when females are asked to work together in learning situations of this sort, but also it appears that simple equal distribution of sexes in treatment groups may be misleading, as more than a main effect seems to be involved. Thus, although the theoretical implications of this interaction are uncertain, the unexpected interaction here reported should be of interest to social psychologists and others concerned with the investigation of various sorts of interpersonal relationships.

Summary of Results

The research studies conducted under this project were designed primarily to contrast learning by performance, in which the subject responds and is immediately given knowledge of results, with learning under observation, where he simply obtains information about associations from seeing someone else's performance record. Generally, we did not replicate the earlier findings, both in the Missouri laboratory and elsewhere, of superior acquisition under observation. A major difference in procedure is that the earlier work involved a chained series of associations (learning a circuit of switches) whereas the present work utilized discrete associations (such as connecting a letter to a picture of an animal); apparently the more complex task, in which more connections must be kept in mind, favors observation, which permits rehearsal as well as involving less strengthening of errors.

The results indicate that male students formed new associations more rapidly under performance conditions and less rapidly under observation conditions; female students showed an opposite tendency. With regard to errors, both sexes definitely showed an increasing tendency towards repetition of errors under performance conditions over trials, while showing a marked reduction in error repetition over trials under observation conditions. Women students working together showed no real improvement over trials under performance or observation, while they showed normal improvement, comparable to all of the male groups, when working alone. Sixth-grade children showed greater observational learning than fourth or fifth-grade children. College students in two experiments learned reliably better in the second of two functions, regardless of whether they were performing or observing, suggesting the importance of a learning-to-learn or a warm-up factor.

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IMPLICATIONS FOR EDUCATION

Two major types of implications for education from this research project may be enumerated. First, there are the implications for further research, either of a primarily pure character (oriented to learning theory) or of a primarily applied character (oriented to classroom instruction and school learning). Second, there are the direct implications for instructional procedures in the classroom. Since these two kinds of implications point in essentially different directions (towards further research or towards utilization of present knowledge), they may best be described separately.

Implications for Research

Learning theory. The research performed under this grant support has stimulated interest in the broad and fundamental question of how response strength changes ("learning," broadly conceived) may best be measured. The plan to use long-term retention and transfer as indices of response strength within the present experimental situation, which could not be carried out during the project because of the lack of time, is now being translated into further research plans directly attacking this problem and involving animal as well as human subjects.

Classroom. These implications, of more immediate concern to the educator, entail the utilization of a common classroom skill, spelling, as a vehicle to permit the simultaneous researching of direct practical (applied) as well as indirectly practical (pure) objectives. Preliminary research on spelling is underway and application has been made for a further grant.

The first purpose of this research is to determine whether elementary school pupils learn language skills more effectively by practicing in pairs than by practicing alone. A second purpose is to test acquisition and retention, and the persistence of errors, under two contrasting methods of study: performance (decision making, with immediate knowledge of results) and observation (equal information provided, but with no direct reinforcement).

The general significance of this project for education is that it will provide a systematic effort to uncover some basic principles of learning that can be applied to certain problems of instruction within the language arts. Systematic investigation of two fundamental functions, performance and observation, with paired or individual practice in a variety of classroom settings, should provide useful fundamental information as to which conditions and which of their interactions are most effective in acquisition and retention. Also, comparison of the way in which spelling and vocabulary skills, which are basic to acquisition of knowledge in all fields, respond to the various experimental manipulations should provide valuable information to the educator who wishes to devise and evaluate instructional procedures.

Implications for Instructional Procedures

The implications for classroom procedures to be drawn from the results of the project now being reported are necessarily limited. Also, any such implications are of course to be treated with considerable caution, since they need to be tested in the field (i.e., the classroom, as described in the brief account given above of the spelling research project) before they can be viewed as confirmed. Nevertheless, some tentative suggestions will be made.

1. There is a suggestion that having learners attempt responses under trial and error conditions ("perform," in the present research framework) may result in their making errors which are relatively resistant to change. (How such errors, or any other errors for that matter, may best be combatted--changed--is another fundamentally important problem and a topic for research that might well be included in the above section also.) As a practical matter, educators could look at present teaching methods and analyze ways in which the attention of learners is engaged by teaching. Subject matter needs to be presented in a manner that does not allow the performance of an error and prevents repetition of the error on the next occasion in training.

It is hoped that the spelling research program mentioned above will throw light on ways in which error strengthening can be prevented (as, perhaps, by making sure that exposure to correct spelling is offered at critical interpolations).

2. Offsetting this first point, there is the apparently contradictory implication that correct responses are also more strongly entrenched, at least in one kind of learning situation we used, when they are being acquired under trial and error (performance) conditions rather than when they are merely observed. Again, how to achieve this desirable result while at the same time avoiding the undue strengthening of errors is a most important research problem whose solution may well involve some kind of combination of processes in instruction. As Skinner has long maintained, classroom instructional methods should aim at having students perform correct responses only.

3. There is the suggestion that observational learning is relatively superior (compared with performance) in older children. This conclusion is suggested directly by the results of the Marx and Marx (1970) experiment. That experiment showed that observational learning, again relative to performance, improved reliably from the fourth to the sixth grade. Educators who plan innovations in teaching methods for classrooms, particularly for the higher age groups, should consider the possibility of using some "observer"-type techniques of training.

4. Finally, there is the suggestion that females are more sensitive to social pressure, as an inhibitor in learning, than males. Whether this result was influenced by one kind of stimulus materials used (geometric patterns), which may have been more familiar to and less aversive for male college students than for female, cannot be said on the basis of the data available at present. This differential sex result did not appear in another study (Marx and Witter, submitted) utilizing more familiar stimuli;

materials (facial features), but that experiment also involved a different type of social pairing procedure--within a larger group of people rather than in an isolated booth. Also, the extent to which this tentative generalization, based on the college student population, can be extended to younger children has not been determined. However, if it is confirmed and found to be of some generality, it could constitute a consideration of some importance for education, suggesting that care be taken to avoid placing undue social pressures (even if of a like-sex character) on girls in learning situations.

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Appendix A

List of Animals Pictured in Elementary School Classroom Experimentation

Set I	Set II
Rabbit	Polecat
Porcupine	Leopard
Reptile	Frog
Weasel	Hamster
Lizard	Coyote
Elephant	Racoon
Chipmunk	Armadillo
Bear	Lemur

Appendix B

Procedure for Elementary School Classroom Experimentation

Preliminary

Arrange seats in pairs, all with clear view of screen. Projector should be placed appropriately and tried out. If possible these arrangements are to be made in advance of the class assemble, such as during a recess period. Give left side S odd number, right side S even number.

Role of Teacher

1. Teacher is to pair students by sex and class achievement level in advance of the experiment, and should provide this information to E. Coding may be used to provide anonymnity, should there be any concern for privacy in the school system.

2. During the experiment, teacher should not be needed, unless the need for discipline cannot be adequately met by E and his assistants. Teacher can ordinarily therefore be allowed to either remain (and watch, or grade papers, etc.) or leave if desired.

Experimental Session

At the start of the session the materials should be passed out upside down, to the children arranged in pairs according to the teacher's classification. If one boy and one girl are left over, they may be paired. If there is one odd child left, either he can be dismissed or perhaps can be paired with a practice teacher, teacher, or an assistant. Ss should be cautioned not to do anything with the materials until instructed.
Materials are:

1. one Rapid Rater per pair
2. one stylus per pair
3. one pencil per S
4. one test sheet (hereafter TS) per S

Experimental Procedure (All instructions provided separately)

1. General Introduction

2. Practice Animal

Show male frigate bird; have left S (facing E) in each pair try Rapid Rater.

3. First Training Trial

For the experiment proper, have the left S of each pair perform for the Set I animals (the first 8), then at the blank slide position have the two Ss exchange roles, with the Rapid Rater going to the right S to be used for the 8 Set II animals. For the first training trial E should operate the projector manually, waiting until he is sure that each S has performed (or observed) properly before advancing to the next slide. Thereafter, the stimuli can be presented at a 15 sec. rate (maximum automatic timing for the Eastman projector). Also, E should call out the appropriate number on the Rapid Rater as each animal appears in order to insure answering in the proper place. It is also particularly important that E and the proctors (assistants) make sure that each performer responds and that the observer is actually observing -- younger children especially have trouble doing this sometimes. However, also be sure that observing Ss do not help performers, and that no talking occurs.

4. First Retention Test

After the first training trial, the first retention test is to be administered, using the first two rows of TS. Here the items are numbered successively across, 1 through 8 and 9 through 16 (for Sets I and II respectively). Nevertheless, E should call out the proper number for each item as the slide appears, to guard against Ss losing their place and getting out of phase. An 8-sec. slide-presentation rate is to be used. E and proctors must guard against copying -- or continuing the "cooperation" just used and emphasized in training.

5. Remaining Training/Retention Trials

The two remaining training and test trials are to be administered in the same manner as the first. The following chart shows the slide arrangement for the first tray:

Sample slide	used once, for practice
16 name slides	used once, for spelling identification
1st order, 16 animal slides	used first for Training Trial 1
2nd order, 16 animal slides	used first for Test Trial 1
3rd order	used first for Training Trial 2
1st order	Test Trial 2
2nd order	Training 3
3rd order	Test Trial 3

6. Collect all materials and thank students and teacher.

Appendix C

Instructions for Elementary School Classroom Experimentation

Note: These instructions are not to be read verbatim to the class but rather the gist of them should be informally given. E should make sure that all Ss are as clear as possible on what they are to do before beginning the experiment proper.

Introduction

This is a learning and memory experiment. We are concerned with comparing how people learn under different methods. Today we would like each of you to try two such methods: one is the usual one of responding in a learning task and then being told whether or not you are correct after each response; the other is simply watching some one else respond in this manner. You will work in pairs, with the student on the left side responding first, while the student on the right side watches, and then you will trade around. Each of you will be tested on all of the items, so you should attend closely when you watch as well as when you perform.

Practice Slide

Now we want to show you how you will work on the task. We will use one slide for practice. The student on the left will respond first. Look at the male frigate bird on the screen (present practice slide).

Naming

Next we want you to see the names of the various animals which are to be used. These names will appear on slides, one at a time. Please notice each name as it appears. (Present 16 name slides)

First Training Trial

Now we are ready to begin the experiment. First the student on the left side in each pair will use the Rapid Rater and stylus. Please do not help each other or talk during the experiment, but remember the student on the right side is to watch closely the results of the guesses. Are you ready now? Are there any questions?

(Show first 8 slides, with manual timing)

Now we are ready to change the Rapid Rater answer sheet, so left-side students should pass it on to their partners, whose turn it will now be to perform. Remember, left-side students now watch.

(Show next slides, again with manual timing)

First Retention Trial

Now we are going to give each of you a test on what you have just learned. For this test, please sit separately, and do your own work. Use the mimeographed test sheets, one to a person. I will call out the appropriate answer number as each slide occurs. You will see the same slides as before, but in a different order. Remember, each of you is to answer for each animal, whether you guessed or observed for it before.

Second Training Trial

We will now have the second training trial, in the same manner as the first, with the left-side student performing first and the right-side student watching. The same animals will appear as before but again in a changed order.

(Present 8 Set I animals, 15 sec. rate)

Now it is time for the right-side student to perform on the answer sheet, while the left-side student watches.

(Present 8 Set II animals, 15 sec. rate)

Second Retention Trial

The second retention test will now be given. Again you are each to work by yourself, using the regular pencil and the mimeographed answer sheets, as before.

Repeat for 3rd retention Trial and Test. Gather all materials and thank students and teachers for their cooperation.

Appendix D

Procedure for First Computer-Controlled Experiment

A. Subject Selection

Procedure for First Computer-Controlled Experiment Subjects were obtained from the summer session introductory psychology class by choosing volunteers. Each subject was required to attend one familiarization session and four experimental sessions during the term; subjects received laboratory credit for the first three sessions and were paid for the last two.

The subjects were scheduled principally according to their own availability, and assigned to one experimental pair per week. They were scheduled so as to counterbalance days between sessions, and to yield different experimental conditions, partners, and stimulus sets each week, while trying to achieve optimum consistency of days run and balance in learning-to-learn effects from one week to the next.

B. Stimulus Randomization

1. 254 line-tilt patterns on individual cards were matched against a random number table according to serial numbers (1-254) on the cards. They were then dealt into four piles of 48 according to the order of numbers in the table, with the restriction that each group of 48 had to include a proportionate number of each complexity (number of lines).

2. The 48 cards were matched against random numbers in order to choose triads, with the restriction that only one card of any single complexity be included in a triad.

3. The triads were randomly ordered by matching with groups of three. (Intra-triad order).

4. Correct designs in each triad were designated by randomly matching triads (one permutation per group of 16 triads) and designating 1 = Left, 2 = Center, 3 = Right, 4 = Left,.....,16 = Left for Group I, then rotating L,C.R, designations to better equilibrate L,C.R, correct over all groups.

5. Order of triads in blocks was determined by random matching, (3 times).

6. Order of triads in tests was determined by random matching, pairing, then random matching of pairs.

7. Restrictions on triads:
   a. Nearly equal L,C,R, correct each set
   b. No two consecutive presentations of same triad
   c. No two designs of same complexity in a triad
   d. No more than two consecutive same correct positions

8. Randomization - preference tests (subject asked which of two stimuli - one previously correct, the other previously incorrect - he "preferred.")

a. Quota per set: 16 correct (all) and 16 incorrect (chosen by random matching set (list order) and choosing 1st correct on even numbers, 2nd correct on odd numbers)

b. 32 from set randomly matched to obtain preference test order

c. 32 extras randomly matched to obtain preference test order

d. Set cards and extras combined; left vs. right obtained by 3rd random match; odd=left, even=right (for member of pair from set used in trial).

e. Preference test orders 2,3, and 4 obtained by random matching 1st order to get 2nd order, etc.

C. Experimental Sessions

Each pair of subjects (ND/NP with D/P or ND/P with D/NP) was given refresher instructions (general instructions having been given at the familiarization session, as well as some experience in each condition), then the session got underway. House lights were dimmed, after which a warning red light signaled the start of the first trial.

Trials were presented in blocks of three, with short periods before each with blinking red lights as a ready signal. Each trial had 16 triads; there 4 blocks of trials in all, each followed by a printed test. Although trials were different in stimulus order within blocks, each block of trials was the same. Tests were different from the acquisition stimuli and from each order in stimulus order.

Reinforcement (red or green light after a press) was superimposed on the design chosen for two seconds; an inter-item interval of three seconds followed, then the next triad. Total presentation time (similar to CI) for each triad was 10 seconds.

Following the four sets of trials and printed tests, subjects were given preference tests paired with new designs. For these, subjects were seated in the booths alone. The IEE cell panel was used, but no red or green lights were shown after the response.

D. Treatment of Data

1. Raw Data: The computer generated the following items of data for each response to an individual triad:

a. Respone (None, left cell, center cell, right cell)

b. Status of response (No response, correct, incorrect)

Data for preference tests were similar to those for the acquisition phase, except all responses were registered "incorrect" on the status item.

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2. Tests: Data were compiled separately for individual tests (Test 1, 2, 3, & 4 across subjects, conditions, and days) and analyzed with a latin-square AOV.

Preference tests were analyzed using the computer; results were not indicative of any significant trends toward preference of new designs to old or vice-versa, either for correct or incorrect old designs.

Appendix E

Questionnaire for First Computer-Controlled Experiment

Now that you have completed the full sequence of conditions in this experiment, we would like you to respond to some questions concerning your experience and the experimental procedure itself. If you have comments concerning any phase of the experiment not covered by the questions please write them at the end of the questionnaire.

1. Did you have any difficulties recalling the procedure from one week to the next - i.e., would more refresher instructions have been desirable?

   A. Yes 2 B. No 18 C. Comments:

2. In the process of going through the triads on the panel, as a decider, do you feel that you ever got "hung up" on the same error for the same triad in repetitions?

   A. Yes 14 B. No 3 C. Sometimes 3

3. Were you conscious of the process of learning correct responses as the sessions progressed, or did you seem to get more and more correct without really being sure of the answers before you gave them? (Referring to work on the panel)

   Conscious 11 Not conscious 1 Both 4 Not Clear 4

   Were you conscious of eliminating previous errors, or of retaining correct answers and continuing to guess at the others?

   Elim. 3 Retain 5 Both 2 Unclear 10

4. Were you able, or did you try to, detect any pattern in the presentation of triads on the panel? Please mention any patterns you detected in one or more of the sessions, other than those specifically mentioned in the instructions.

   Able to detect pattern 2
   Tried to detect pattern 7
   Unable to detect pattern 10
   Pnemonic 1

5. Did the occurrence of tests seem to disrupt the process of learning the triads, i.e., would more consecutive repetitions have been more desirable for the purpose of learning?

   Disrupt 5
   Not Disrupt 11
   Tests Distracted 3
   Red Signal Distrubed 1

6. Did you seem to reach an optimum performance level (on the panel) toward the end of the session, or did your performance first improve then decline again? Circle the number of the block (3 trials between tests) in which you feel you generally performed the best.

Block 1 2 3 4
Circled 0 2 7 11

Please number the experimental conditions in order of preference, starting with #1 most preferred (not necessarily the condition in which you performed the best):

Observer 4 Decider 2 Performer 3 Decider-Performer 1

Why? Preferred D/P condition

7. Was it easy or difficult to maintain the condition assigned throughout the session (especially for Decider-only and Performer-only conditions)?

Easy 7 Difficult 3 Conditional 5

8. Did you ever observe your partner having similar difficulties - if so in which cases (no names necessary)?

Answers varied - no clear trend

9. How well do you feel you learned in the different conditions, as manifested in your test performance? Please number the conditions starting with #1 - estimated best learning, and add any comments you feel are relevant

Observer 1 Decider 2 Performer 3 Decider-Performer 4

Same as #6

10. Do you feel that you made progress in your ability to learn the sets of triads over the 4 weeks?

Yes 14 No 4 Not Sure 2

11. Did you find the paper tests to be significantly different from the triads on the panel?

Yes 20

Did this difference, if any, cause you difficulties in transferring your learning on the panel to the written test?

Yes 17

Do you feel the written tests were an accurate reflection of your learning on the panel?

Yes 3 No 13

How might any difficulty of this type be corrected?

Test with photos of panel 6
With various adjustments 7
Don't know 7

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12. Would it have been better to have the tests on triads on the panel rather than on paper, as was done for the Likes-Dislikes tests?

Yes 15 No 3

13. Did you find it hard to change over from your mode of responding on the triads when the Likes-Dislikes tests were presented?

Yes 2 No 16

14. On the Likes-Dislikes tests:

A. Was it easy to make a decision or did you feel there was not enough basis for a decision?

Yes 15 No 4

B. Did you find some designs which seemed familiar or similar to those in the triads? If so, did you choose them more readily than unfamiliar designs?

Yes 15 No 6 Yes 8 No 4

C. Did you tend to choose designs which reminded you of things outside the laboratory - such as crosses, flags, letters, etc.?

Yes 9 No 9 Conditional 2

15. The overall time spent on the triads per session was?

a. Too much 4
b. Not enough to accomplish anything 2
c. OK 13

16. Is there anything which could or should be done to make this type of task more interesting (short of converting our triad panel into a slot machine)?

No 11 Yes 4 Don't Know 5

17. Keeping in mind the questions above and your own reaction to the task, do you think that the difficulties encountered were caused by the experimental procedure per se, or be the nature of the task trial?

Procedure 2 Task 9

18. Which condition, in your opinion, was best for <u>learning</u> (vs. the one which you preferred the most - if these happen to be the same please answer accordingly)?

Observer 2½
Decider 5½
Performer 0
Decider-Performer 11
No Preference 1

Why? Answers in order of mention

1. More involvement in decide conditions - self-satisfaction - 8.
2. Making own decision, more attention to problem - 4 (D cond.).
3. Social aspect of being decider, living up to other person's expectations - 3.
4. Cooperation with partner - 1.
5. Observer condition easier - 1.

Appendix F

First Computer-Controlled Experiment

This is a learning experiment. We are interested in determing how quickly people learn, and remember, under a variety of different conditions. This study involves learning to discriminate between various visual patterns. These patterns are composed of lines tilted at various angles, and presented in groups of three, or triads. Because we are interested in obtaining results that are as free as possible of prior learning and memory we have developed a set of simple visual patterns the exact samples of which you are not likely to encounter very often in everyday life (unlike numbers and words, which are also widely used in human learning research). Because these figures are composed of lines of varying tilts they will all tend to be very similar and discriminating among them will not be easy. However, after a number of trials through these materials you will find that you are beginning to recognize the various triads, and also to remember which patterns are right and which are wrong in each of the triads.

Since one goal of this study is to determine which of four different learning conditions is the most effective, subjects are run in pairs, as follows: one possible pair consists of a person who decides which of the three designs to respond to and performs the response himself by pressing a button beneath the cell on which the desin appears, and another person who observes the proceedings without actively participating. The other possible pair is one person who decides on the design plus the other person, who actually performs or presses the button. The "decider" in this case never presses the button, nor does the "performer" make any choices. You will be given practice today on each of the four possible conditions in the four following weeks. Regardless of which condition you are in, however, you will be encouraged to learn the correct designs and will be given written tests on them during the sessions. The order of events for one session will be as follows:

When the study begins you will be seated in a booth before a panel of three circular light cells. The designs will appear on the cells, a different one for each cell, and you will choose the correct one of the three. The first couple of choices, of course, may involve guessing, since you will not know in advance which ones are correct. Out of each group of three designs, or triad, however, only one is correct; this correct design will appear with the same two incorrect ones each time it is presented, and in the same arrangement of the three designs. The triads will be presented one at a time until all of them appear once; or for one trial, then a ten second rest period will occur, followed by the triads in a different order, another rest period, then the triads for a third time. The beginning of each trial will be preceded by a red light which will flash as a ready signal just before the first triad appears. When the person assigned to press the button does so, a green or red light, signifying correct or incorrect, will flash on the design.

The idea is to recall which of the three is correct and choose it in subsequent presentations: it may help if you consider each triad as a single large design or arrangement and remember which part of it is correct. After the triads have each been presented for three trials, the lights in the booth will be turned up and you will be asked to fill out a short test form, with the triads printed on it, by checking the correct one of each set; you can see a sample form today and practice filling it out. After four test forms are accumulated the day's session will be over with. Each week's session will involve a different set of designs, so there will be no need to remember correct ones from one week to the next, and no point in telling other subjects about the designs. Since we are trying to measure the effect of different types of learning experience, we expect as little conversation as possible in the booths during the sessions. A standard statement of "left", "center", or "right", if one subject is choosing and one is pressing the button, will be sufficient. For the pairs where one subject is merely observing the decider-performer should call out "left, center, right" as he makes the choice.

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Appendix G

Final Statement to Subjects

First Computer-Controlled Experiment

This past summer you have helped to provide information about a topic of interest to many Psychologists, observational learning (OL). OL is of interest to the Social Psychologist by its relationship to imitative behavior, but is relevant to the Learning theorist as well, since it offers an opportunity to somewhat separately consider the processes of decision making, information processing, and the role of reinforcement, as well as covert versus overt motor activity. This consideration is of pragmatic as well as theoretical concern, since in the "typical" learning situation, these activities are all occurring together.

In the experiments in which you participated, you took the role of both a performer and observer, and decider or nondecider, to study the effect of the above processes in a simple discrimination task. In the four conditions employed, you had the opportunity to perform and process information, but not actually decide (P-ND), simply observing outcomes of anothers choices (NP-ND), or of putting into action the choices you actually made (P-D). These combinations provide very useful information about the utility of OL by separating to some extent the different activities of learners.

The present experiment was concerned with whether this task could be learned by OL, and with the effect of practice in the different conditions. For example, if OL is not effective the first time, might it be more so if the person repeated in another condition, e.g., P-ND then NP-ND? In addition, is performance in non-OL conditions affected by prior OL experience in the same task, e.g., P-D after possible conditions, with different people getting them in different orders. Analysis of these data will provide answers about OL in the discrimination situation, and about the role of practice, as well as allowing refinements in the techniques and apparatus for future experimentation. Questions of interest for further study include the role of OL in more complex situations.

The following references provide more information about this general idea:

Flanders, J. P. A review of research on imitative behavior. Psychological Bulletin, 1968, 69, 316-337.

Rosenbaum, M. E., & Arenson, S. J. Observational learning: Some theory, some variable, some data. In E. C. Simmel, R. A. Hoppe, & G. A. Milton (Eds.), Social Facilitation and Imitative Behavior. Boston: Allyn & Bacon, 1968.

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